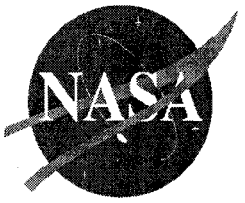

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National Aeronautics and
Space Administration

SUBSA/PFM-GUIDE-001
April 04, 2000

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Risk Management Database Guide

For the

Solidification Using A Baffle in Sealed Ampoules (SUBSA)

And

Toward Understanding Pore Formation and Mobility During Controlled Directional Solidification (PFM)

Investigations

Prepared by

Materials Sciences Program Office
Microgravity Science and Applications Department

Enclosure 4

Marshall Space Flight Center
National Aeronautics and Space Administration

MSFC Form 454 (Rev. October 1992)

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Approved by:

Linda Jeter 6/6/00

Linda Jeter — Date

Project Manager

Concurrence:

Paul Luz — Date

System Engineer

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1.0 INTRODUCTION

1.1 Purpose – The purpose of the Solidification Using A Baffle In Sealed Ampoules (SUBSA) /Pore Formation and Mobility (PFM) Risk Management Database Guide is to provide a tool for the project team explaining the methodologies and processes to be used for SUBSA/PFM risk identification, assessment, analysis and mitigation. A database has been constructed for tracking risks identified by the SUBSA/PFM team members, and this document is a guide for understanding and using that database. The database provides criteria for categorizing or ranking risk according to probability and consequences, and provides the documentation requirements for risk management products and actions. Risk management is best implemented and accomplished at the project level, and the intent of this guide is to help the project produce a quality product within programmatic, schedule and cost constraints. This guide is for use by the project team only to manage and implement risk with respect to the risk management requirements called out in Section 16 of the respective Project Plans. The risk management approach for SUBSA/PFM applies to internal and external risks for SUBSA/PFM, and uses NPG 7120.5A, NASA Program and Project Management Processes and Requirements, and SSP 50175, Risk Management Plan, as guidelines. SUBSA/PFM risk management responsibilities and the role of risk management with respect to decision-making, formal reviews and status reporting are defined in the SUBSA Project Plan, MSAD-PLAN-0001 and the PFM Project Plan, MSAD-PLAN-0002.

Although the SUBSA and the PFM are two separate investigations, they are combined into this single Risk Management Database Guide because the project teams are the same, they share some hardware, each uses the Microgravity Science Glovebox (MSG), and both are scheduled for the same flight.

1.2 Scope - The Risk Management Database Guide covers the entire SUBSA/PFM scope, which includes the following:

- Schedules – as defined in MSAD-PLAN-0001, SUBSA Project Plan and MSAD-PLAN-0002, PFM Project Plan
- Costs – as defined in MSAD-PLAN-0001, SUBSA Project Plan and MSAD-PLAN-0002, PFM Project Plan
- Science Objectives – as defined in SD46-SRS-SUBSA, SUBSA Science Requirements Sheets and SD46-SRS-PFM, PFM Science Requirements Sheets
- MSFC Quality Plan, MSFC-PLAN-2889, SUBSA Project Plan, MSAD-PLAN-0001 and PFM Project Plan, MSAD-PLAN-0002
- Contractual, Interface, and Safety – as defined in MSFC-ICD-3054, MSG ICD for PFM; MSFC-ICD-3086, MSG ICD for SUBSA; and the System Requirement Documents SD42-RQMT-001 for PFM and SD42-RQMT-0002 for SUBSA.

1.3 Project Organization – The SUBSA/PFM project team consists of the primary contractor, Tec-Masters Inc. (TMI), the University of Alabama in Huntsville (UAH), the MSFC Project Manager (PM), the MSFC Systems Engineer (SE), Safety and Mission Assurance office

(S&MA), Project Scientist (PS), and engineering support from various engineering directorate disciplines as deemed necessary. Sections 7.0 of the SUBSA Project Plan and the PFM Project Plan address management organization and responsibilities.

1.4 Project Description - The SUBSA hardware is described in the SUBSA Project Plan and the PFM hardware in the PFM Project Plan.

1.5 Project Objectives –The SUBSA flight investigation objectives are listed in the SUBSA Project Plan and the PFM objectives in the PFM Project Plan.

2.0 APPLICABLE DOCUMENTS

The following documents of the latest issue (unless otherwise specified) form a part of this guide to the extent specified herein. In the event of a conflict between the documents specified herein and the contents of this guide, the contents of the SUBSA Project Plan and the PFM Project Plan shall be considered the superseding requirement. Quality Records will be maintained in accordance with SD40-OWI-003. The SUBSA Project Plan and the PFM Project Plan contain a listing of the Quality Records associated with risk management.

MSAD-PLAN-0001	SUBSA Project Plan
MSAD-PLAN-0002	PFM Project Plan
NPG 7120.5A	NASA Program and Project Management Processes and Requirements
SD46-SRS-SUBSA	SUBSA Science Requirements Sheets
SD46-SRS-PFM	PFM Science Requirements Sheets
SD40-OWI-003	MSAD Quality Records Process
SSP 50175	Risk Management Plan
MSFC-ICD-3054	MSG ICD for PFM
MSFC-ICD-3086	MSG ICD for SUBSA
SD42-RQMT-0001	System Requirements for PFM Hardware & Software
SD42-RQMT-0002	System Requirements for SUBSA Hardware & Software

3.0 ACRONYMS/ DEFINITIONS

3.1 Acronyms

CPIF	Cost Plus Incentive Fee
GI	Glovebox Investigator
MSFC	Marshall Space Flight Center
MSG	Microgravity Science Glovebox
NASA	National Aeronautics and Space Administration
NPG	NASA Policy Guideline
PFM	Pore Formation and Mobility
PM	Project Manager
PS	Project Scientist

ROM	Rough Order of Magnitude
S&MA	Safety and Mission Assurance
SE	Systems Engineer
SOW	Statement of Work
SRS	Science Requirements Sheets
SUBSA	Solidification Using a Baffle in Sealed Ampoules
TMI	Tec-Masters Inc.
UAH	University of Alabama in Huntsville

3.2 Definitions

Threat - a concern that is perceived to have a potentially adverse impact on the achievement of program goals and objectives.

Risk Management - the identification, assessment, analysis, mitigation, and disposition of risks at each stage of the project.

Risk - a threat that has been assessed and found to have sufficient probability of occurrence and/or severity of consequences such that it may have a significant impact on the program baseline. Risks should be identified at the lowest practical level and documented in the database on Risk Information Sheets. An example of a Risk Information Sheet is shown in Figure 1. Actual database chosen for use may cause a change in format.

Risk Analysis - studying potential solutions to identified risks to determine the most appropriate method to mitigate the risk.

Risk Assessment - the process of determining the probability that an event will occur and the resultant consequences. Each identified risk denotes the possibility that an adverse event will occur.

Fail safe point - a point in the mitigation process where a "fallback" method or recovery plan will be enacted if the risk has not been reduced to a defined threshold.

Risk Mitigation - strategy developed and implemented to mitigate identified risks based on the results of risk analysis.

Closed Risk - a risk item is considered closed if it no longer poses a threat or has been accepted with sufficient supporting rationale.

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RISK INFORMATION SHEET

Identified

ID		Originator	Payload
Priority		Statement	
Probability			
Impact			
Rev. Change			
Time Frame		Origin / Class / Assigned to:	

Context

Mitigation strategy

Coningency plan and trigger

Status | Status Date

Approval | Closing date | Closing rationale

4.0 RISK MANAGEMENT APPROACH

4.1 Risk Management Philosophy – SUBSA/PFM is being developed under a Cost Plus Incentive Fee (CPIF) contract. Consequently, TMI is responsible for hardware specification, performance, and reliability internal to the project. However, these risks may be elevated and monitored by the government as appropriate. The project team will focus upon integration, safety, quality, science and interface risks associated with satisfying the requirements stated in the Science Requirements Sheets (SRS) and the Statement of Work. Project resources will be applied to assure mission critical capabilities, and to minimize risk with respect to cost containment, schedule maintenance, and achieving baseline objectives as identified in the SUBSA Project Plan, MSAD-PLAN-0001 and the PFM Project Plan , MSAD-PLAN-0002.

4.2 Roles and Responsibilities - The MSFC SUBSA/PFM Project Manager is responsible for risk management on the SUBSA/PFM Project, as stated in Sections 16, Risk Management, of the SUBSA and PFM Project Plan.

The PM and the project team will prioritize and track open risks for the SUBSA/PFM project. Each risk will be assigned to a primary reviewer, who will track the risk until it is dispositioned. The primary reviewer will provide risk status monthly during project team meetings. Through the risk assessment process, described in Section 5.2.1, risks will be given priorities of "High", "Medium", and "Low", based upon their rankings in the Risk Matrix, reference Figure 2, part of the SUBSA/PFM Risk Management Database. Actual database chosen for use may cause a change in format. Once the primary reviewer identifies a risk as imminently occurring, the Project Manager will work with the primary reviewer and the team to develop mitigation and disposition action, including a schedule for accomplishing mitigation, a cost impact, and contingency plan if required. The project team and/or primary reviewers will identify new risks or significant changes to existing risks monthly during team meetings.

The SUBSA/PFM project team members are responsible for the following:

- Identifying risks, documenting the risks in the SUBSA/PFM Risk Management database, statusing risks, analyzing the identified risks, and supporting the project in developing mitigation options if necessary. This process is accomplished using the guidelines and procedures provided in Section 5 of this plan.
- Identifying and communicating how risks from their respective area might affect other program elements.

Risk Matrix

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H (High) - Implement new process or change baseline plan(s)

M (Medium) - Aggressively manage; consider alternative process

L (Low) - Monitor

What is the Probability the situation or circumstances will happen?

Level	DCPCG Team current process...
5	.. cannot prevent this event, no alternate approaches available
4	.. cannot prevent this event, but a different approach/process might
3	.. may prevent this event, but additional actions may be required
2	.. is usually sufficient to prevent this type of event
1	.. is sufficient to prevent this event

Probability					
5	L	M	H	H	H
4	L	M	M	H	H
3	L	M	M	M	H
2	L	L	L	M	M
1	L	L	L	L	M
	1	2	3	4	5
	Impact				

Given the event occurs, what is the magnitude (Impact level) of the impact to DCPCG Team?

Level	1	2	3	4	5
Category					
Technical	Minimal or no impact	Moderate performance reduction, same approach	Moderate performance reduction workarounds	Major performance reduction workarounds available	Unacceptable, no alternatives
Schedule	Minimal or no impact	Additional activities required. Able to meet Milestone	Key milestone slip < 1 month	Key milestone slip > 1 month Or Program Impacted	Cannot achieve key Team or major Program miles
Cost	Minimal or No impact	Budget increase <5%	Budget increase >5%	Budget increase >10%	Budget increase >15%

5.0 RISK MANAGEMENT PROCESS

The following section outlines the specific guidelines to be used by the SUBSA/PFM project team for risk management. The risk management process should follow the guidelines and procedures listed in this section. Figure 3 depicts the SUBSA/PFM risk management process that will be implemented by the project team.

5.1 Risk Identification - The SUBSA/PFM project team shall identify risks by continually reviewing the safety, quality, science, and interfaces, as well as contractual baseline requirements, schedules, costs and all other relevant project elements. These items will be assessed against the project baseline to ensure that the technical, cost, and schedule objectives support compliance with project and Program requirements. Risks can be identified at any time during the project. Risk management is a continual process, and is updated as new information becomes available. Risk identification methods to be used include, but are not limited to, expert interviews, independent assessment, lessons learned files from previous projects, and failure analysis. The following elements, while not an all-inclusive list, should be used to identify areas that need to be addressed in the risk identification process:

1) Technical Risk Sources
   - Requirements changes
   - State-of-the-Art Advance
   - Complexity/difficulty in meeting requirements
   - Percent proven technology
   - Special resources needed
   - Operating environment
   - Degree difference from existing technology

2) Physical Properties
   - Thermal
   - Mass
   - Power
   - Vibration
   - Envelope

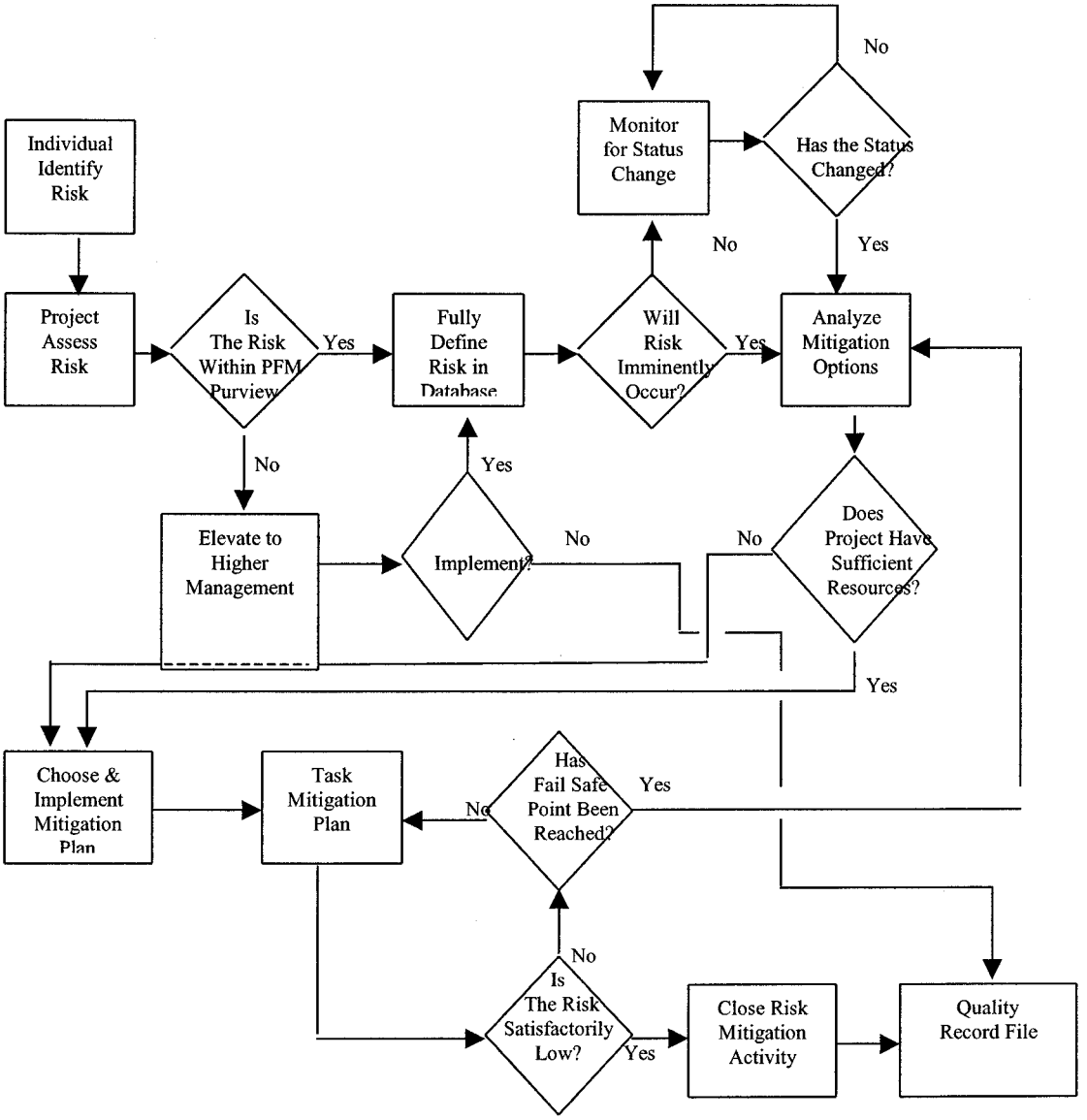


Figure 3
SUBSA/PFM Risk Management Process Flow Diagram

3) Integration/Interface Risks
- Design Maturity
- Compatibility
- Controllability
- Deployability
- Survivability
- Vulnerability

4) Software Design Risks
- Code estimates reasonable?
- Functional requirements complete?
- Test procedures complete?
- Critical modules identified?
- Hardware constraints defined?
- Code complexity required
- Code compatibility

5) Critical Failure Modes
- Reliability
- Maintainability
- Redundancy/Fault Tolerance
- Fault Detection
- Fault Correction

6) Schedule Risk Variables
- Sensitivity to technical and cost risk
- Availability of materials, personnel, and test facilities
- Communication delays/errors
- Change in requirements
- Test failures

7) Cost Risk Variables
- Sensitivity to technical, performance and schedule risk
- Realistic cost estimates

8) Supportability Risk Variables
- Manpower
- Facilities
- System safety
- Spares
- Lead times
- Data Management
- Funding

5.2 Risk Analysis - Risk analysis is used to ascertain as accurately as possible the likelihood of an identified risk causing detrimental effects to a program, the full consequences of such an event, and a determination as to whether mitigation actions are required. If risk mitigation is not pursued, the project will continue to aggressively monitor the identified risk. The following subsections describe major areas of risk analysis.

5.2.1 Risk Assessment - The SUBSA/PFM project team will determine the likelihood that identified risks will materialize and have detrimental. Experiences in other programs, safety hazard analyses, continuous monitoring of interface and project level documentation, and utilizing personnel expertise in similar systems, are examples of techniques that will be used by the project to determine probability of occurrence estimates.

A SUBSA/PFM Risk Matrix (Figure 2), contained in the SUBSA/PFM Risk Management Database, will be used to evaluate risks. This risk matrix approach allows a subjective measure of the risk areas identified; however, it does not provide an absolute measure of the risk. Using this system, the project team can rank risks in order of priority, categorize impacts to other SUBSA/PFM elements, provide summaries and relative values of the likelihood of occurrence and potential consequences of each risk to the Project Manager.

5.2.2 Impacts to Cost and Schedule - Analysis will be performed to determine the impact of cost and schedule risks to the project. If cost or schedule impacts are expected to be significant, an analysis will be performed to determine how the expected schedule slip or cost overrun will affect the program. For significant cost risks, Rough Orders of Magnitude (ROM) estimates will be developed and for significant schedule risks, critical path analysis will be provided. The SUBSA/PFM Project Manager will determine the budget source to mitigate risks that have cost impacts.

5.2.3 Impacts to Technical Performance - If the SUBSA/PFM system is brought to completion on time and within cost, but its performance fails to meet the science requirements stated in the SRD, the system may still be considered acceptable. This scenario is entirely dependent upon the science requirements under consideration and degree of degradation. If the predicted technical performance falls below required levels to a degree that will have unacceptable effects, then mitigation action must be taken. Non-conformance with technical requirements must be identified. Compromised requirements may include areas such as technical performance, functional requirements, safety, and weight. Compromises of safety requirements should be discussed with the governing Safety Panel prior to implementation. Subsequent evaluation should quantify the negative impact of the risk on system performance, and degradation shall be assessed as a function of the magnitude of the impact on the entire SUBSA/PFM system.

5.3 Risk Mitigation - Once a risk has been identified and the probability and consequences are assessed per the risk matrix contained in the database, the project will develop a mitigation strategy only for risks with a high probability of occurrence. Mitigation actions usually fall within the following areas:

1. Schedule alterations: Develop work-a-rounds to remove the item from the critical path, apply more resources to the activity to reduce its expected duration, or assign schedule reserve, if feasible, to the item at risk.

2. Cost management: Redirect money from other areas of the project or allocate reserve funds if possible.

3. Technical performance: Investigate the availability of an off-the-shelf item, add tests to monitor progress, evaluate alternate sources, seek help from experts in related technical disciplines.

4. Acceptance: Accept the risk as-is. Higher-level management approval is required to accept risks in the "high" and "medium" category.

5. Descope: Evaluate descope options, impacts of descoping, and benefits of descoping.

Each individual risk item will lend itself to specific mitigation activities. It is the responsibility of the SUBSA/PFM team members to generate viable mitigation actions, if mitigation is the path chosen to follow. Figure 3 contains a flow diagram of the SUBSA/PFM Risk Management Process. Sections 5.3.1 through 5.3.3 describe the phases of the risk mitigation process.

5.3.1 Identify Mitigation Options - The SUBSA/PFM team members will support the Project Manager in developing specific mitigation options for individual risk items. Only risks that have a high probability of occurring will be required to have mitigation plans. The Project Manager will approve the mitigation actions to be taken. It is important that all areas of program risk (cost, schedule, technical, and safety), be considered in the generation of mitigation options. The project team will analyze and assess each option, and will perform an initial "screening" to remove any options that are not feasible from consideration.

5.3.2 Assess Mitigation Options - Each mitigation option will be analyzed to ensure that other risks are not induced or worsened by the solution. Following this assessment, the most effective course of action will be chosen. Each option must be reviewed to address both internal and program-wide impacts. Impacts to the following areas must be identified:

- Schedule: The amount of time the mitigation plan will take to implement the impact on the critical paths, and a determination if sufficient resources exist to support the plan.
- Costs: Non-recurring and life cycle costs.
- Technical: System performance, operations, safety, and interfaces.

From the mitigation options identified, the appropriate mitigation strategy will be selected by the PM and Systems Engineer, based on recommendations by the other team members.

5.3.3 Implementation Strategy - Once a mitigation option has been chosen, the project will develop a mitigation plan. This plan will include the technical tasks involved; the required cost deltas for implementing the plan, the schedule impacts; and the manpower and other resources required to implement the plan. The SUBSA/PFM Risk Information Sheet (Figure 1),

contained in the database, will be utilized for the collection of the required risk information. The Mitigation Plan will be an attachment to the Risk Information Sheet and will identify steps required to close the risk item. Figure 4 shows an example of the format for the Mitigation Plan, which will be contained in the SUBSA/PFM Risk Management Database. Actual database chosen for use may cause a change in format. The plan will have the following characteristics as a minimum:

1. Each plan shall define a set of tasks/actions with a defined schedule. A SUBSA/PFM team member will be identified as the focal point for each action.

2. Identified risks and mitigation plans will be statused at team meetings and presented at management reviews.

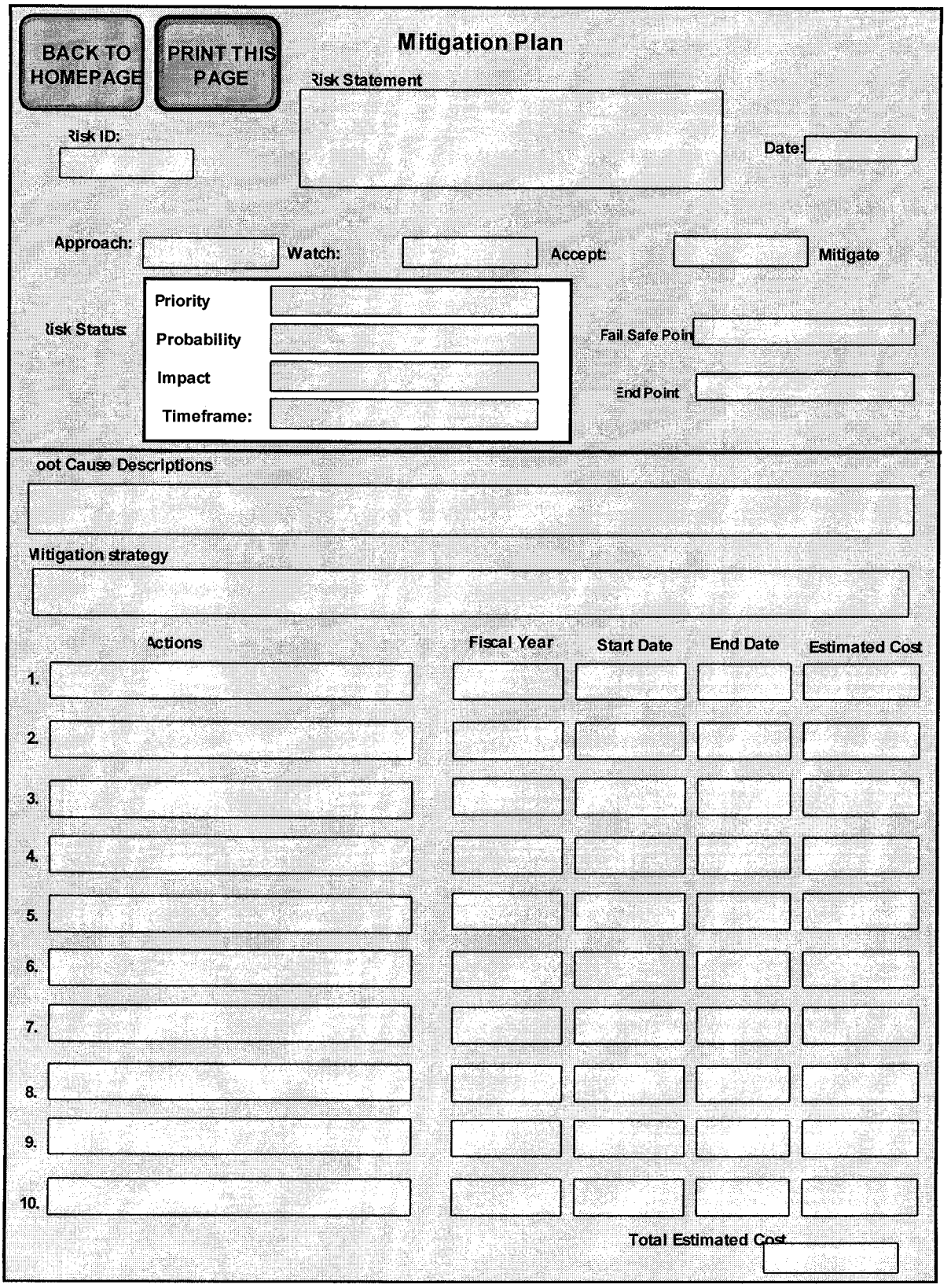
3. The plan will contain a "fail safe" point. This will be a point in the plan where a "fallback" method or recovery plan will be enacted if the risk has not been reduced to a defined threshold.

4. The plan will contain an end point including closure criteria. An end point is a point in the program that can be defined (i.e. when a hardware item is qualified or drawings are back on schedule).

The PM will coordinate activities necessary to assure the accomplishment of the mitigating action. These activities include officially notifying TMI and the GI, initiating procurement actions, assigning and tracking actions within MSFC or other NASA centers. Risks may be identified which fall outside the immediate scope of the SUBSA/PFM project, or which are sufficiently significant to require higher-level management attention and direction, for example, when risk mitigation requires additional funding outside the SUBSA/PFM project control and/or budget. When such a risk is identified, higher-level management will be notified, and options for mitigation presented.

6.0 RISK MANAGEMENT DOCUMENTATION AND ARCHIVING

All SUBSA/PFM risk management products and action items will be documented in the SUBSA/PFM Risk Management Database, and managed by the SUBSA/PFM PM. This database includes a Risk Spreadsheet listing of identified risks, Risk Information Sheets and associated Mitigation Plans, and any resulting risk action items. The SE will track, document, and analyze the SUBSA/PFM risk management data as defined in this guide and/or as directed by the PM.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Mitigation Plan
Risk Statement
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Date:
Approach:
Watch:
Accept:
Mitigate
Risk Status:
Priority
Probability
Impact
Timeframe:
Fail Safe Point
End Point
oot Cause Descriptions
Mitigation strategy
Actions
Fiscal Year
Start Date
End Date
Estimated Cost
1.
2.
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8.
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Total Estimated Cost